Appendix D

Deepwater Horizon Event and Potentially Affected Environmental Resources in EPA Region 4 Jurisdictional Area Outer Continental Shelf Gulf of Mexico

United States Environmental Protection Agency

Region 4
61 Forsyth Street, SW
Atlanta, GA 30303

Updated April 2016

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Summary

The incident at the Deepwater Horizon drilling platform (Macondo-1 well) in April 2010 created the largest oil spill in the history of the U.S., releasing approximately 4.1 million bbl of crude oil into the Gulf of Mexico. After 87 days of flow, the well was capped in July 2010. The Macondo-1 well site was approximately 145 kilometers from the Louisiana coast, located southwest of the mouth of the Mississippi River. The wellsite is located in an area under the NPDES administrative jurisdiction of EPA Region 6, and is 32 kilometers from the administrative boundary of EPA Region 4. The bulk of the oil was released off the coast of Louisiana, but eventually oil spread east of the mouth of the Mississippi River along the Mississippi, Alabama, and Florida coastlines, reaching Panama City, Florida.

The oil spill and response represented a major event that had the potential to affect the environmental conditions in the area covered under the proposed EPA Region 4 Offshore Oil and Gas NPDES General Permit. The material presented in this appendix discusses recently available information on the impacts of the event on environmental resources in the Gulf of Mexico and the potential for these impacts to change the environmental conditions of these resources and render them more vulnerable to potential impacts resulting from discharges authorized by the proposed General Permit.

Deepwater Horizon Impacts on Physical Resources

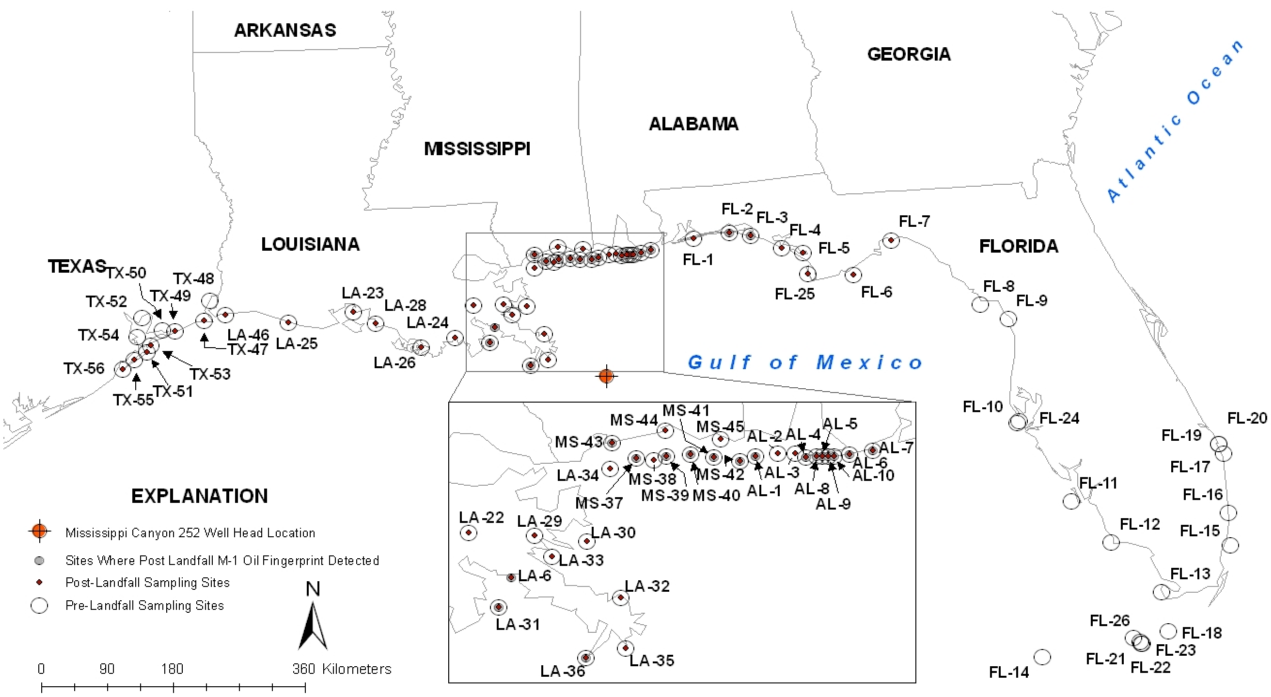
Water Quality

BOEM (2015b) re-examined the analysis for coastal and offshore water quality presented in its earlier NEPA documents (BOEM, 2012a; 2013a; 2014a) and concluded newly available information did not provide sufficiently compelling data that would change its environmental baseline for water quality to alter BOEM's conclusions in its earlier NEPA reviews.

Several studies, detailed below, have demonstrated the Deepwater Horizon incident adversely affected water quality, both at the spill site and in coastal waters from Louisiana to the Florida panhandle. These studies also support the relatively rapid return of water quality to near pre-spill conditions within a year for organic compounds. However, data on trace metals and other major elements were confounding and highly variable, with multiple aquatic life and human health exceedances in both pre-and post-spill surveys.

Coastal water samples at 70 sites from Texas to Florida were analyzed before (between May 7 and July 7, 2010) and six months post-landfall of Macondo-1 oil (October 4 to 14, 2010) (Figure 1; Nowell et al., 2011; 2012). High priority was given to coastal wetlands, Department of Interior lands at risk for oil contamination, such as NWR, Bureau of Land Management (BLM)

FIGURE 1 USGS SITES SAMPLED IN RESPONSE TO THE DEEPWATER HORIZON OIL SPILL



Source: Nowell et al., 2011; 2012

lands, National Seashore areas, and State Parks. Water samples were collected to represent surf and suspended-sediment conditions at the time of sampling. Samples were collected in water 0.6 to 0.9 meters in depth, from depths of 15 to 30 centimeters below the surface but at least 15 cm from the sea bottom to avoid collection of re-suspended bottom material.

In five post-landfall samples (four in Florida; one in Mississippi) toluene was the only organic with elevated levels). However, six trace metals or major elements were elevated in post-landfall samples. No samples exceeded aquatic benchmarks for human health for 11 organic contaminants with available benchmarks; only two elements had human-health aquatic benchmarks and neither was exceeded. Among 73 available aquatic life benchmarks, only one post-landfall sample from a South Pass/Mississippi River site had elevated levels of aromatic organics substances. However, for trace metals, chronic aquatic life benchmark exceedances occurred in pre-landfall samples in every state except Florida and all five states in post-landfall samples, including B (48 post-landfall samples); Cu (22 samples); Mn (12 samples); Ba (2 samples); and Pb, Ni, V, and Zn (1 sample each).

Total dissolved *n*-alkanes (C9 – C35) and PAH in suspended particulates from Macondo-1 oil were, respectively, some 10-fold higher in May samples than August samples in 2010 and 5-fold higher in May 2010 samples than May 2011 samples (Liu et al., 2014). The authors concluded surface waters were contaminated by the oil spill in May 2010, but rapid weathering and/or physical dilution had reduced hydrocarbon levels by August 2010. Their results are consistent to a degradation half-life of approximately 20 days for three Macondo-1 oil components (Zhou et al., 2013).

Seawater samples collected from April to July, 2010 by Sammarco et al. (2013) showed total petroleum hydrocarbons (TPH) levels peaked near Pensacola, Florida; a secondary peak occurred near Galveston but was not definitively shown to be from Macondo-1 oil. Two-, three-, and four-ring aromatic hydrocarbons showed a primary peak offshore Pensacola and a secondary peak south of the mouth of the Mississippi River. TPH and PAH levels were high with respect to human consumption and both chronic and acute marine biota (Sammarco et al., 2013), unlike levels previously reported that were below benchmark values (NOAA, 2010; Sammarco, 2010; Ylitalo et al., 2012: all as cited in Sammarco, 2013). The authors suggested the discrepancy between their data set and NOAA's could be from sampling equipment differences or from sampling a heterogeneous distribution of hydrocarbons.

Water quality impacts from hydrocarbons were closely monitored by NOAA, which issued 34 fishing closures in federal waters that peaked at some 230,000 square kilometers (37% of the Gulf), but were all cancelled by April 19, 2011 (NMFS, 2015d; NOAA, 2015b).

Based on the above water quality data, the acute water quality impacts of the Deepwater Horizon event appear to have been temporary. There is considerable uncertainty over whether any latent impacts (e.g., impacts to eggs or larvae) can be determined.

Sediment Quality

BOEM (2015b) re-examined the analysis for coastal and offshore sediment quality presented in its earlier NEPA documents (BOEM, 2012a; 2013a; 2014a) and concluded newly available information did not provide sufficiently compelling data that would change the environmental baseline for sediment quality to alter BOEM's conclusions in its earlier NEPA reviews.

Studies have demonstrated organic and metal sediment chemistries were affected by the Deepwater Horizon event, with increased levels of contaminants observed on a time scale of at least years for both near coastal and deepwater environments. Data are not yet available to provide sufficient trend data from which recovery times could be determined or projected. Sediment toxicity data indicate sediments from coastal sites post-landfall may be slightly more toxic than seen in pre-landfall samples.

Sediment samples were collected from 70 inshore sites along the Florida, Alabama, Mississippi, Louisiana, and upper Texas coasts (Figure 3-16) in May and June 2010 before the Deepwater Horizon oil making landfall. Wet-sediment core samples were collected from a 2-square meter or larger area at the land/water interface (swash zone) on beaches and from bottom materials of streams that dissect wetland or marsh areas. For post-landfall samples, samples were collected from an area and at a depth horizon to which oil could have penetrated. Beach sediment samples were collected to a depth of 25 cm from the swash zone. Where possible, post-landfall sediment collection was conducted at a comparable stage of tide as the pre-landfall sample collection at the same site. Marsh sediment samples were collected from a depth of 10 to 15 cm in submerged sediment.

Comparing pre-spill sediment samples, with samples collected six months post-landfall, the concentrations in 20 of 49 organic analytes were significantly higher than in pre-spill samples; two analytes (naphthalene and oil and grease) had higher pre-landfall levels. The observed differences were not due to changes in sediment TOC. Post-landfall samples had a higher percentage that exceeded upper screening-value benchmarks than pre-landfall samples (37% versus 22%). However, there was no significant difference between pre- and post-landfall percentages of sediment samples that exceeded at least one benchmark value for organic contaminants (Nowell et al., 2011; 2012).

For alkylated PAHs with statistically higher concentrations in post-landfall samples, five coastal sites had the largest concentration differences (three in Alabama; one each in Louisiana and Mississippi). Diagnostic geochemical evidence in post-landfall sediment, tarballs, or both, indicated Macondo oil as contributor to PAH contamination at these five sites. In pre-landfall samples from these sites, the summed chronic equilibrium-partitioning sediment benchmark toxic-unit concentration (ΣESBTU) values for PAH mixtures resulted in no screening-level benchmark exceedances. However, ΣESBTU values from these five sites exceeded multiple upper screening-level benchmarks for total PAHs in six of seven samples, including at least one from each site (Nowell et al., 2011; 2012).

In pre-landfall samples, trace quantities of oil were detected at 45 of 69 nearshore, coastal waters sites in tar ball and sediment samples. Three different oil groups were identified, dispersed along the Gulf of Mexico coastline, but none correlated with the Macondo-1 well oil. Results at a site near Marathon, Florida, however, suggested some Macondo-1 oil may have entered a loop current and been transported to the Florida Keys before the oil spill made landfall (i.e., “pre-landfall”) along the northern Gulf coast.

In post-landfall sampling, Macondo-1 well oil was genetically linked with 11 of 49 sediment samples and 17 of 20 tarballs. None of the sediment hydrocarbon extracts from Texas correlated with Macondo-1 well oil. Oil-impacted sediments were confined to the shoreline adjacent to the cumulative oil slick of the Deepwater Horizon oil spill Louisiana, Alabama, Mississippi, and Florida, and no impact was observed outside of this area (Rosenbauer et al. 2010; 2011; and Wong et al., 2011).

A study of over 3,000 deepwater sediment samples collected at 534 sites around the Macondo-1 well site delineated a 3,200 km^2 area (equivalent to an approximate radius of 32 km) of sediment contamination from the Deepwater Horizon event that was estimated to represent 4% to 37% of the released oil. Results suggested a dual mode of deposition, one from an oil-rich layer of water impinging laterally on the continental slope at about 900 to 1,300 meters deep and a higher-flux, “fallout plume” from which suspended oil particles sank to sediments at 1,300 to 1,700 meters deep (Valentine et al., 2014).

In coastal sediments, a few trace and major elements showed significant differences in whole sediment between post-landfall and pre-landfall samples. Also, 40% of pre-landfall samples versus 57% of post-landfall samples exceeded empirical upper screening-value (i.e., probable-effect range) benchmarks. For the fine (< 63 µmeter) sediment fraction, concentration differences were insignificant. Lead and mercury were significantly higher in pre-landfall than post-landfall whole-sediment samples; authors noted differences in fine sediment levels could have contributed to this finding (Nowell et al., 2011; 2012).

Over a three-year time series at three deepwater stations, concentrations of redox sensitive metals (Cd, Mn, Re) changed, showing sediment Re levels had increased 3-4 times pre-spill values for the first two years, but had decreased in the third year (Hasting et al., in press).

Surficial sediment samples were collected from the 70 inshore sites along the Florida, Alabama, Mississippi, Louisiana, and upper Texas coasts (Figure 3-16) in May and June 2010 before the Deepwater Horizon oil making landfall (Biedenbach and Carr, 2011). Extended holding times and unacceptable temperatures during shipment resulted in 17 of those samples (representing 15 sites) meeting the criteria for quality control; therefore, only those 17 samples were tested in the pre-landfall sampling round. In October 2010, surficial sediment samples were resampled at 49 sites along the Gulf Coast. Despite variations in the sampling protocols between pre- and post-landfall, toxicity results are comparable as all tested samples were collected with inert materials and met the quality control criteria upon arrival at USGS.

Sediment toxicity was marginally affected based on pre- versus post-landfall sediment samples. Sediment fertilization toxicity was seen in 3 of 17 pre-landfall pore-water samples collected in each of the five affected states, although none were observed at below the detectable significance criteria (DSC) levels; 4 of 17 samples showed embryological sediment toxicity. Post-landfall analyses showed 3 of 49 samples exhibited fertilization toxicity and 6 samples exhibited embryological toxicity Biedenbach and Carr (2011).

Based on these sediment quality data, sediment quality impacts were observed a few months after the Deepwater Horizon oil spill; recovery appears to be occurring on a timescale of several years. Sediment toxicity shows no clearly quantifiable pattern, but appears to be spatially heterogeneous. The spatial extent appears to extend to some 40 km, but patchiness in the deposition of spilled oil confounds an effort to quantify reliably the magnitude of the impact. There is considerable uncertainty over whether any latent impacts (e.g., impacts to eggs or larvae) can be determined.

Air Quality

Air quality impacts, primarily localized, were observed as a result of the Deepwater Horizon event that persisted during the spill and response. Available data on the Deepwater Horizon event and current air quality data are sufficient to determine that impacts to ambient air quality ceased with the termination of the spill and response activities and are not expected to have any impact on the attainment status of current air quality resources in the Gulf area.

Coastal Barrier Beaches

BOEM (2015b) re-examined the analysis for coastal barrier beaches presented in its earlier NEPA documents (BOEM, 2012a; 2013a; 2014a) and concluded newly available information did not provide sufficiently compelling data that would change the environmental baseline for coastal barrier beaches to alter BOEM's conclusions in its earlier NEPA reviews.

Several studies examined the impact of the Deepwater Horizon event on beach microbial community structure and function. Oiling of beaches altered microbial community composition on a time scale of a few months; recovery to typical, if not identical, community composition appeared to have occurred within one to two years. PAHs were bioaccumulated in beach clams, but returned to pre-landfall levels within two years.

After oiling, changes in microbial communities of sandy beaches along the northwest coast of Florida showed a succession pattern from early populations that utilized aliphatic hydrocarbons to specialist populations that utilized aromatic hydrocarbons. Changes occurred within 3 months and lasted for up to one year following the oiling of beach sands, after which no oil was detected, and the population reestablished to typical, but different from pre-oiling, microbial beach communities (Rodriguez et al., 2015).

Pre-landfall sand microbial communities at two sandy Gulf coast beaches were typically fecal contamination-associated bacteria. After oiling, a significant shift occurred from fecal indicator taxa to taxa associated with open-water and marine systems similar to hydrocarbon degraders identified near the oil plume. Sand washing and tilling occurred on both beaches, and community changes also were correlated with sediment and grain size distributional changes (Engel and Gupta, 2014).

At two Louisiana beaches, the rate of biodegradation and microbial community composition varied with position relative to the tidal zone. The most efficient degradation occurred in supratidal samples and some intertidal, samples (Urbano et al., 2013). However, the intertidal regime also was found to severely limit biodegradation of submerged oil mats (Elango et al., 2014).

From June through November, 2010, seven Gulf of Mexico beaches from Bay St. Louis, Mississippi, to St. George Island, Florida, had unique bacterial communities. Oiling increased the variability in community composition among all sequencing groups -- core, resident, and transient -- indicating community-wide impacts rather than an overprinting of oil hydrocarbon-degrading bacteria on the otherwise relatively stable sand communities (Newton et al., 2013).

Coquina clams from Florida panhandle beaches bioaccumulated PAHs (i.e., higher levels of PAHs relative to the sand substrate). PAH levels were highly variable but overall, decreased continuously to method detection limits in sand and clams, respectively, within one and two years after beach oiling (Snyder et al., 2015).

Based on these data, coastal barrier beach impacts were observed a few months after the Deepwater Horizon oil spill. Recovery appears to be occurring on a timescale of several years. However, available data are not sufficient to understand the potential long-term impacts to barrier beaches from the Deepwater Horizon event. There is considerable uncertainty over whether any latent impacts could be detected, and the data are insufficient to make a reliable determination about long-term impacts.

Onshore Waste Management

Collection and disposal of solid and liquid wastes from the Deepwater Horizon spill and response occurred under the direction and oversight of the Deepwater Horizon Unified Command. EPA worked with BP to identify landfills in the Gulf region that had appropriate design criteria and were legally permitted to receive the different types of waste generated from the spill and response. EPA and affected states reviewed the compliance history of each facility. BP's approved Waste and Material Tracking and Reporting Plan (BP, 2010) listed 20 landfills -- 3 in Mississippi, 13 in Alabama, and 4 in Florida -- that were approved to accept Deepwater Horizon wastes. In addition to state oversight and inspections, EPA conducted site visits to landfills twice each month.

Despite the large amount of wastes collected during the Deepwater Horizon event, the impact of these wastes for onshore waste management were negligible, based on a comparison of the amount of wastes generated to landfill capacity. As of November 28, 2010, the Deepwater Horizon solid wastes requiring onshore disposal totaled 89,202 tons; liquid wastes totaled 1,193,084 bbl (Kubendran, 2011), which assuming a 55-gallon drum and specific weight of 8.5 lbs/gallon, amounts a total of 278,883 tons.

Just considering waste capacity at one of the approved landfills, the Chastang Landfill in Alabama, the combined total of 368,085 tons represents 519 day-equivalents at the current disposal rate of 709 tons per day or 213 day-equivalents at the maximum permitted rate of 1,725 tons per day (Mobile County Solid Waste Disposal Authority, 2005). This one-time utilization amounts to 1.67% of the available Chastang landfill capacity. The Deepwater Horizon event had a negligible impact on available landfill capacity at just one landfill.

Deepwater Horizon Impacts on Biological Resources

Marine Mammals

The effect of the Deepwater Horizon event on marine mammals has produced confounding data on its potential impact. NMFS declared a UME for whales and dolphins in the Gulf of Mexico from February 2010, some three months prior to the Deepwater Horizon event. The UME is ongoing, has lasted far longer, and has seen many more strandings than any previous UME (NMFS, 2016). Persistent organic chemicals (POP; principally, pesticides and insecticides) also were potential contributors to the UME (Balmer et al., 2014). However, summed POP levels in 108 male dolphins did not differ significantly geographically, and overall POP levels were in the low-average range compared to previously reported levels for dolphins. Disease also was a potential contributor to the UME, and as of October 2015, a bacterial pathogen, Brucella, was positive or suspected positive in 68 of 210 dolphins tested.

Disease as a contributing factor was assessed. Venn-Watson et al. (2015a) compared post-Deepwater Horizon-exposed dolphins and a reference group of dolphins A low incidence of Brucellosis (7%) and morbillivirus (11%) infections were detected post-Deepwater Horizon, and biotoxin levels were low or absent, indicating infection was not a primary cause of death.

Bottlenose dolphins from heavily-oiled Barataria Bay were compared with oil–free dolphins from Sarasota Bay (Schwacke et al., 2013). The Barataria Bay dolphins had elevated occurrences of overall poor health and body condition, hypoadrenocorticism, and higher incidence of lung disease, which are uncommon effects consistent with petroleum hydrocarbon exposure. Bacterial pneumonia and thin adrenal cortices, which are rare, life-threatening, diseases consistent with exposure to petroleum compounds, were more likely in post-Deepwater Horizon dolphins, and elevated hydrocarbons were thought to contribute to dolphin mortalities.

Other environmental stressors also appear to have contributed to the UME and result in dolphin populations more vulnerable to effects from the event. Litz et al. (2013) reviewed data from multiple studies of UMES declared from 1990 -2014. (Hansen, 1992; Miller, 1992; Duignan et al., 1996; Colbert et al., 1999; Avens et al., 2012; Carmichael et al., 2012; USGS, 2013; as cited in Litz et al., 2013). Low temperature and low salinity were factors in six UMEs:

- 1990 – low temperature was determined to be a contributing factor the East Matagorda Bay, Texas, dolphin UME
- 1986-1990 -sea surface temperature was found to be inversely related to stranding in Texas
- 1992 - low salinity from heavy rainfall was determined to be a contributing factor in the Texas UME
- 2010 – in January, low air and water temperatures were determined to be causative in a severs sea turtle stranding event in Florida, including the Panhandle
- 2010 – increased dolphin strandings in Lake Pontchartrain from February to April occurred concurrently with lower than average salinity in the lake

- 2010 – early in the year, fish kills associated with cold water were reported in some bays, estuaries, and shallow water areas throughout the Gulf during early 2010
- 2011 – low temperatures and a large influx of freshwater from an unusually heavy snow pack was suggested as causative factors to dolphin mortalities in 2011.

Several authors have examined methodologies for assessing population level impacts. Williams et al. (2011) evaluated the methodologies that are used to assess potential cetacean population level impacts. Their analysis found that the estimated, historical carcass-detection rates for 14 cetacean species in the northern Gulf of Mexico represented only 2 - 6% of the estimated total population mortality. They concluded that failing to include an estimate of the carcass recovery rate would produce substantial underestimates of population effects. Using a statistical approach to estimating occupancy and number of manatees in Florida, Martin et al. (2014) estimated fewer than 2.4% of potentially affected manatee habitats may have been occupied, resulting in an upper estimate of 46 - 107 manatees affected by the Deepwater Horizon event.

In response to the Deepwater Horizon event, dispersants were used to break up oil slicks. The dispersants used in the response were later examined and found to be cytotoxic and genotoxic to sperm whale skin cells (Wise et al., 2014a). In addition, elevated Ni and Cr levels, which are known as genotoxic to sperm whales, were found in post-spill whale samples. How relevant these studies are to field impacts in not yet known.

EPA performed toxicity tests on Louisiana sweet crude (LSC) oil and a suite of dispersants, including Corexit 9500A, which was used in the Deepwater Horizon event response (Hemmer et al., 2010). Dispersant only, LSC only, and dispersant/oil mixtures were test using *Americamysis bahia*, an aquatic invertebrate, and *Menidia beryllina, (*inland silverside), a small estuarine fish. The concentration at which 50% of organisms exposed for 4 days to the test substances were estimated to survive (the 96-hour LC50) for Corexit9500A was some 15-fold less toxic than LSC only (LC50 = 42 ppm versus 2.7 ppm for mysids; LC50 = 130 ppm versus 3.5 ppm for Menidia). The Corexit 9500A/LSC mixture showed LC50s for mysids and Menidia, respectively of 5.4 ppm and 7.6 ppm. Thus, for both species, the Corexit9500A/LSC mixture reduced the 96-hour LC50 of the oil-only exposure by half. EPA results also indicated that none of eight dispersants tested, including Corexit 9500A, displayed biologically significant endocrine disrupting activity (EPA, 2010a).

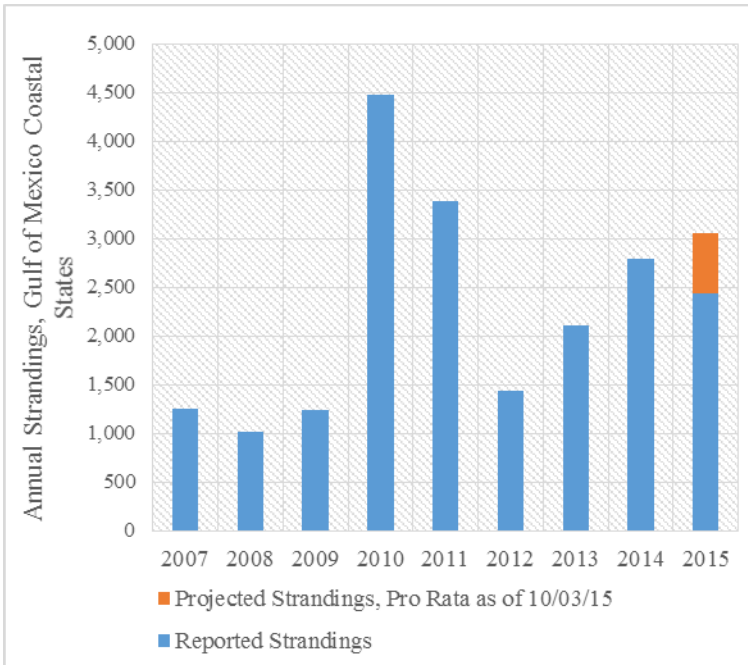
Although the Deepwater Horizon event is likely involved, the relationship of potentially significant contributing factors to the marine mammal UME in the Gulf and its potential long-term effects on these populations is not known. The current status of bottlenose dolphins in the northern Gulf of Mexico is that several stocks appears to be under a stress or stresses that are not yet understood. These stocks (e.g., the Barataria Bay stocks) are primarily located west of the area of coverage of the proposed General Permit.

Sea Turtles

Kemp's ridley sea turtle nests increased exponentially from 1966 to 2009, when 19,163 nests were observed (Gallaway et al., 2013). In 2010, the number of nests declined to 12,377. The number of nests appeared to rebound in 2011 and 2012, in which 19,368 and 20,197 were respectively observed. The authors indicated that the cause of the 2010 crash, and whether the number of nests will continue to increase, is not clear. During the spill and response, some 600 dead turtles were collected, of which 75% were Kemp's ridley turtles. Others have noted oil accumulated in sargassum mats, where young Kemp's ridleys tend to rest and eat (Ocean Conservancy, 2015).

The Sea Turtle Stranding and Salvage Network (STSSN) has documented large numbers of stranded sea turtles in the north-central Gulf of Mexico since 2010. The majority of these turtles have been endangered Kemp's ridleys, loggerhead, and green turtles. NOAA, with the STSSN and Gulf states is investigating many possible reasons for the increase, included: fishing; biotoxins, such as harmful algal blooms; and impacts from the Deepwater Horizon Event.

FIGURE 2 ANNUAL SEA TURTLE STRANDINGS, GULF OF MEXICO, 2007-2015



Source: NOAA Southeast Fisheries Science Center, 2015. http://www.sefsc.noaa.gov/stssnrep/SeaTurtleReportI.do?action=reportquery

The NOAA Southeast Fisheries Science Center (SEFSC, 2015) reported yearly strandings of sea turtles that were fairly stable from 2007 to 2009 (Figure 2). In 2010, a roughly four-fold increase occurred compared to pre-Deepwater Horizon event strandings. Strandings declined by two-thirds from 2010 to 2012, yet remained about twice as high as 2007-2009 strandings. Since 2012, strandings have steadily increased to about three times higher than pre-spill levels.

The timing of the spill and strandings pattern implicates the Deepwater Horizon event as a factor. Based on overall sea turtle annual stranding patterns, the overwhelming majority of Kemp's ridley turtles observed among collected dead turtles, and the dramatic decline in the number of their nests in 2010, inferentially it appears the Deepwater Horizon event may have had an acute impact on sea turtles. Nesting data suggest recovery may have occurred on a time scale of a year or two, but there are insufficient data to ascertain long term impacts beyond a few years.

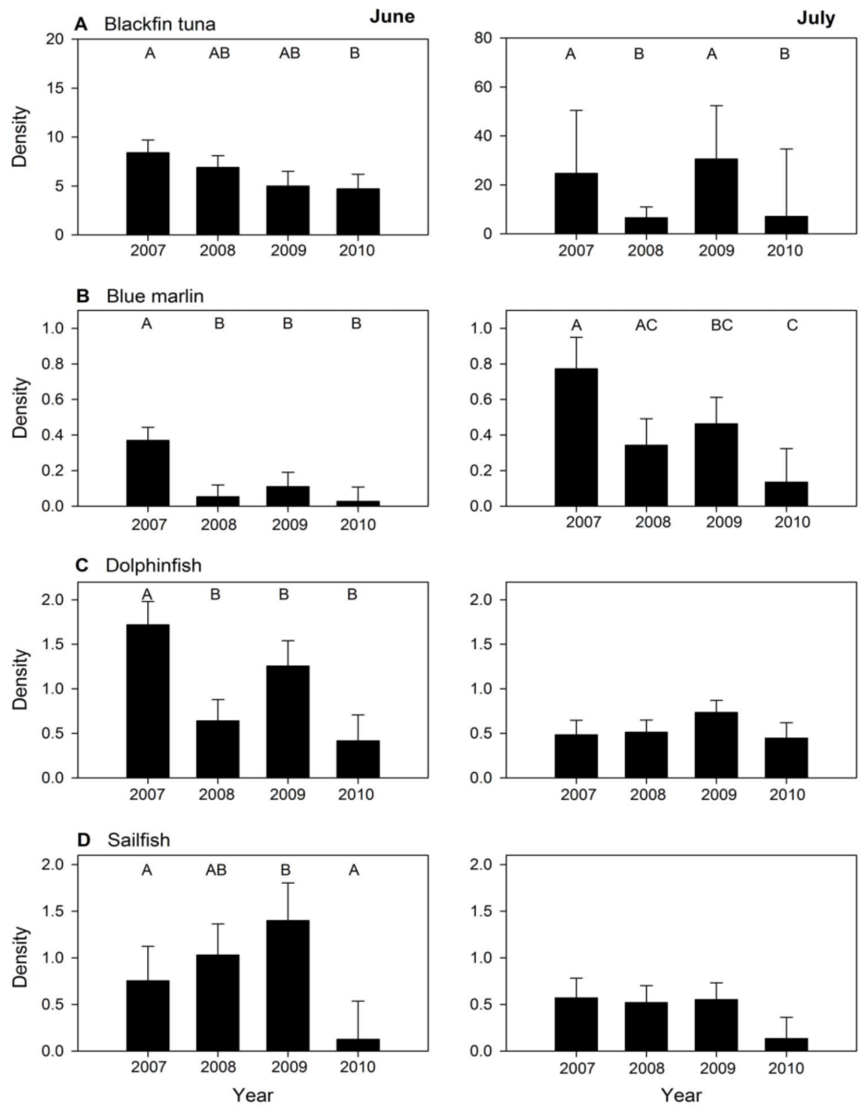
Strandings data are a source of concern with respect to long-term impacts of the spill, showing a quick decrease in the two years after the spill but a substantial increase over the following three years. Available data are not adequate to understand potential long-term impacts on sea turtles. However, as with the case of dolphins, there may be other natural and anthropogenic factors contributing as well. A substantial difficulty in determining a cause of death in sea turtles is most sea turtle carcasses wash ashore moderately or severely decomposed and provide little meaningful information. The current status of sea turtles is that the population appears to be under stress, and although the Deepwater Horizon event is likely involved, the relationship among potential contributing factors is not well understood. The current status of sea turtles suggest both the Deepwater Horizon event and other potential natural stressors, have resulted in sea turtle populations that are under increased stress.

Fish and Essential Fish Habitat

Studies conducted on organismal and population responses of estuarine fishes to the Deepwater Horizon spill were assessed by Fodrie et al. (2014). In ten of the organismal response studies reviewed, some type of positive (adverse) effect from the oil/dispersant exposure occurred. In six studies evaluating the response of populations, only one indicated a positive (adverse) response to oil, with a marginal decline in total catch numbers, although not within individual species numbers. The authors suggested the difference between organismal and population-level effects could result from factors that could either obscure or dampen population-level responses.

Larval abundance in 2010 for blackfin tuna, blue marlin, and dolphinfish generally were not significantly different from 2008 or 2009 (Figure 3). In contrast, sailfish larval abundance was not significantly different from 2007 (Rooker et al., 2013). Modeling and electronic tag data indicated the spill area coincided with areas used by adult blue marlin over the previous three years, although the occurrence of blue marlin in the spill area was noted as lower in 2010 than in previous years.

FIGURE 3 LARVAL ABUNDANCE OF EPIPELAGIC FISH



Source: Rooker et al., 2013

Juvenile coastal fish recruitment into the seagrass beds along the northern Gulf of Mexico from the Chandeleur Islands, Louisiana to St. Joseph Bay, Florida was examined by Fodrie and Heck (2011). Based on data from 853 trawls from July to October, 2006 through 2010, overall catch rates and CPUE of the most abundant species were consistently higher in 2010 than 2008 or 2009 and, in some areas, higher than all previous years. Twelve of the 20 most abundant taxa showed statistically higher catch rates in 2010; pre- and post-spill catch rates for remaining taxa were statistically indistinguishable.

A study of juvenile and adult marsh fish assemblages collected two and three years after the Deepwater Horizon event collected in Caminada, Terrebonne, and Barataria Bays, Louisiana, found there were no significant differences in abundance or species comparisons between oiled and unoiled sampling sites in marsh habitats (Able et al., 2014).

A modeling study assessed the potential loss of bluefin tuna larvae from the Deepwater Horizon event and its potential population impact (Atlantic Bluefin Tuna Status Review Team, 2011). The estimated loss of larvae was about 20%, which resulted in less than a 4% reduction in spawning biomass, based on historical catch rates; this estimate did not account for any loss of adults to oil toxicity.

An oyster reef restoration project along the Alabama coast showed marshes subject to light oiling had a significant reduction in recruitment of transient species to coastal nursery habitats between 2009 and 2010, but appeared to return to pre-Deepwater Horizon event levels from 2011 through 2012 (Moody et al., 2013).

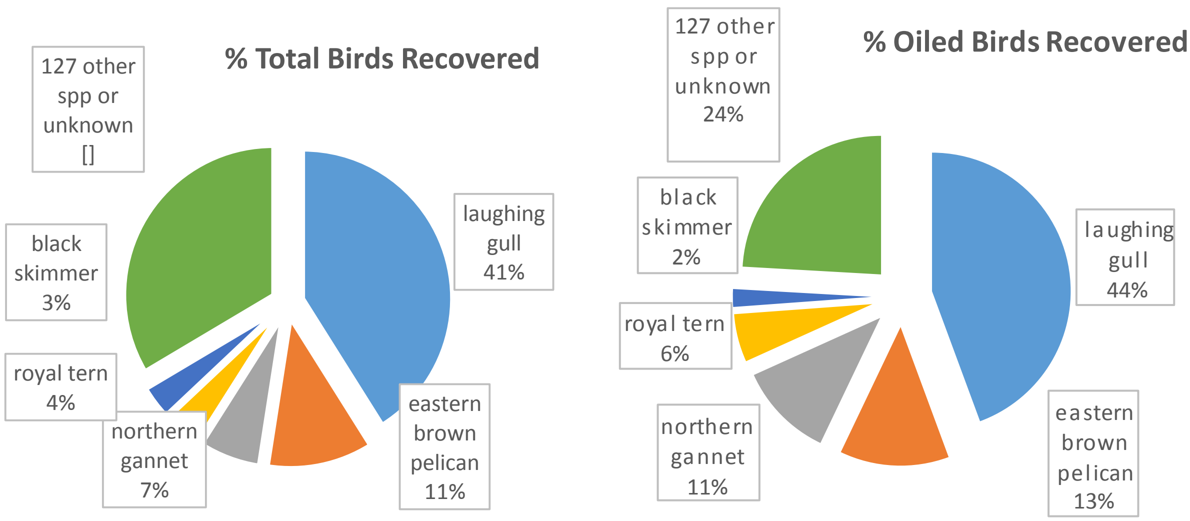
BOEM (2015b) re-examined its analysis for fish resources and EFH presented in its earlier NEPA reviews (BOEM, 2012a; 2013a; 2014a) and reviewed new, available information. BOEM concluded available information is incomplete and long-term effects cannot yet be known. However, currently available data indicate impacts from the Deepwater Horizon event are largely indistinguishable from natural variability or other anthropogenic (human-caused) activities and do not indicate significant population-level effects have occurred.

Limited data indicate sublethal effects on embryos, juvenile, and adult fish may have occurred from the Deepwater Horizon event. However, field studies either have not discerned any oil spill-related impacts or, if such impacts occurred, affected populations appear to have recovered within a few years of the spill. Combined with commercial and recreational fish data (Chapter 3.6.3.1 and 3.6.3.2, below), it appears any Deepwater Horizon event impacts may have been transient. However, impacts that have not yet been expressed in present fish populations cannot be discounted, e.g., differential age-class impacts that have yet to be observed. While the available data suggest there has been no major impact thus far on fish populations in the Gulf, the current information is not sufficient to make a reliable determination about long-term impacts.

Birds

BOEM (2015b) re-examined the analysis for birds presented in its earlier NEPA reviews (BOEM, 2012a; 2013a; 2014a) and reviewed newly available information. BOEM acknowledged there still is incomplete or unavailable information relevant to assessing the impacts of the Deepwater Horizon event on birds.

FIGURE 4 PERCENTAGES OF TOTAL BIRDS RECOVERED AND TOTAL OILED BIRDS FOLLOWING THE DEEPWATER HORIZON OIL SPILL AND RESPONSE



Source: FWS, 2011

As of May 12, 2011 as part of the FWS post-Deepwater Horizon event monitoring and collection process, 7,258, individual birds representing 132 different species/groups (104 identified species and 28 unidentified groups) were collected (FWS, 2011). More birds were recovered that were not oiled than birds that were oiled or of an unknown status (36.7% oiled; 46.7% unoiled; 16.9% unknown oiling). The five species most-impacted by the spill, based on the percentage of oiled versus un-oiled birds, were all representatives of the seabird group: laughing gull (1,182/2,981); Eastern brown pelican (339/826); northern gannet (297/475); royal tern (149/289); and black skimmer (55/253). The percentages of total birds that were recovered and total oiled birds are shown in Figure 4. All species listed above, except the northern gannet, have representative breeding populations in the northern Gulf of Mexico (Hunter et al., 2002, 2006; FWS, 2010d).

Population effects on seabirds affected by the 'persistent' Deepwater Horizon event and the 'rapid' 1989 Exxon Valdez spill were compared in Belanger et al. (2010). The study assessed live and dead bird collections on Days 38 - 110 and Days 110 - 138 of the Deepwater Horizon event and total live and dead birds from Deepwater Horizon and Exxon Valdez events. The average dead bird collection from Days 38 - 138 increased significantly (from 48.2/day to 63.2.day) while the average collection of live birds significantly decreased (from 20.8/day to 7.1/day).

The authors found the Exxon Valdez spill yielded 1,630 live birds (4.7%) and 35,000 dead birds while the Deepwater Horizon spill, some five-fold larger than the Exxon Valdez spill, yielded 2,080 live birds (26.9%) and 7,726 dead birds. The conclusion that a 'persistent' spill affected fewer birds than a 'rapid' spill was one of multiple reasons that could account for the lower numbers collected during the Deepwater Horizon event, e.g., the shift in live verses dead birds, the mode of collection, and lack of experienced collection personnel. The study also suggested any response effort should entail a response surge as early as possible to collect and rehabilitate any live seabirds rather a drawn out continuous response effort.

Based on these recent studies on the impact of the Deepwater Horizon event on bird populations, limited data indicate lethal effects occurred to avian species, especially on seabirds whose range extensively overlaps that area in which the spill occurred. There is considerable uncertainty over whether any latent impacts can be determined. The currently available information is not sufficient to make a reliable determination about long-term or population-level impacts.

Deepwater Benthic Communities

BOEM (2105b) re-examined its analysis for deepwater benthic communities in its earlier NEPA reviews (BOEM, 2012a; 2013a; 2014a) and reviewed new data. BOEM noted the patchy distribution of chemosynthetic communities throughout the Gulf would minimize the proportion of communities potentially affected by any single event (BOEM, 2015b). BOEM also noted that although ongoing research projects are investigating these impacts, long-term effects may not yet be detectable and necessary information may not be obtained and available for years.

Sediment and biota samples from 170 stations, of which 68 were located 0.5 - 125 kilometers from the Macondo-1 wellhead, showed strong and moderate chemical impacts clustered mostly near the wellhead (Montagna et al., 2013). The most severe reduction of faunal abundance and diversity extended to 3 kilometers from the well in all direction; moderate impacts extended 8.5 kilometers to the NE, 17 kilometers SW, and 37 kilometers SW of the wellhead. There was no correlation to distance from natural oil seeps.

Impact of the Deepwater Horizon event on 11 deepwater coral community sites were examined 3 to 4 months after the well was capped and at 7 sites previously visited in September 2009 (White et al., 2012). Healthy coral communities were observed at all sites >20 kilometers from the well. At a site 11 kilometers SW of the well, of 43 coral images at the site, 23% of the images showed impact to more than 90% of the colony; 46% of the images exhibited evidence of impact on more than half of the colony; and 85% of the images exhibited some indication of impact. Hopanoid petroleum biomarkers isolated from a brown flocculent material (floc) covering coral indicated the material contained oil from the Macondo-1 well.

The effect of the floc on a deepwater coral community located 11 kilometers SW of the wellhead was examined during 5 trips over 17 months beginning on November 3, 2010 (Hsing et al., 2013). About 6 weeks after the initial cruise, on the second trip, hydroid colonization was present. Floc was absent after the third trip in March 2011. The authors noted impacts were patchy, suggesting constituents in the floc may not be homogenous. Hydroid colonization showed a significant positive correlation with the proportion of the coral initially showing visible impact. The apparent recovery of affected branches by March 2012 was inversely proportional to the level of initial impact to the colony.

Seafloor surveys deepwater corals were conducted by Fisher et al. (2014) after the Deepwater Horizon oil event. At one site within 6 kilometers SE of the wellhead over 90% (63/68) of the coral showed signs of recent stress; a site 13 kilometers SSW of the wellhead showed 72% (39/54) of corals with signs of stress; and a site 22 kilometers ESE from the wellhead showed stressed corals were 23% (7/30) of those assessed. At sites 10 - 19 kilometers from the wellhead, low levels of stress were noted (5 - 20% of corals affected). Deepwater Horizon event impacts on deepwater coral communities appeared to be very heterogeneous.

Radiocarbon dating to determine the approximate age and growth rates of corals potentially impacted by the Deepwater Horizon event (sampled in 2010 and 2011) found the oldest corals within 11 kilometers of the oil spill were over 600 years old with radial growth rates between 0.34 - 14.20 μmeters/year (Prouty et al., 2014).

Based on these studies, the Deepwater Horizon event appears to have had serious adverse effects on deepwater coral, which are long-lived and slow growing. Deepwater Horizon impacts extend some 40 kilometers from the wellhead, but the impact pattern is very heterogeneous. Benthic surveys document multiple deepwater coral communities that were unaffected by the spill and some degree of recovery appeared to occur over a few years.

Although knowledge is limited, seriously affected coral do not appear to be common beyond 10 to 20 kilometers or so, except along transects aligned with predominant currents and bathymetry. The studies presented in this EA present knowledge of the immediate impacts to deepwater coral communities, but little understanding of 'long-term' impacts for communities that have existed for 460 to 600+ years (Prouty et al., 2014).

Based on these recent studies on the impact of the Deepwater Horizon event on deepwater coral communities, the limited data indicate the Deepwater Horizon incident has had significant adverse effects on certain deepwater coral communities. However, the impacts also appear to have occurred heterogeneously and, at most, within about 40 kilometers of the Macondo-1 wellhead. At this time the data are insufficient to make a reliable determination about long-term impacts.

Live Bottoms

BOEM (2015b) noted that the Pinnacle Trend feature nearest the Macondo-1 wellhead is approximately 60 kilometers to the north, and the highest concentration of Pinnacle features is 100 kilometers to the northeast. Documented benthic impacts northeast of the wellhead have not extended beyond 8.5 kilometers, far from the nearest low relief feature. The greatest impacts have been noted in the general direction nearly directly opposite that of Pinnacle Trend or live bottom, low relief habitats.

Investigations of deepwater corals following the Deepwater Horizon event indicate the distance to which observable impacts have been documented is determined by prevailing currents and bathymetry. Substantial chemical impacts, in all directions, appear to be found within 3 kilometers of the wellhead; moderate chemical impacts were noted 8.5 kilometers NE of the wellhead.

Coral impacts have not been documented far north of the Deepwater Horizon well. Substantial impacts were observed at communities 6 kilometers SE, 11 kilometers SW, and 13 kilometers

SSW from the wellhead and moderate impacts noted 22 kilometers ESE and 37 kilometers SW from the wellhead. However, other sites beyond approximately 20 kilometers showed low or no impacts. Impacts to deepwater communities appears to be highly heterogeneous.

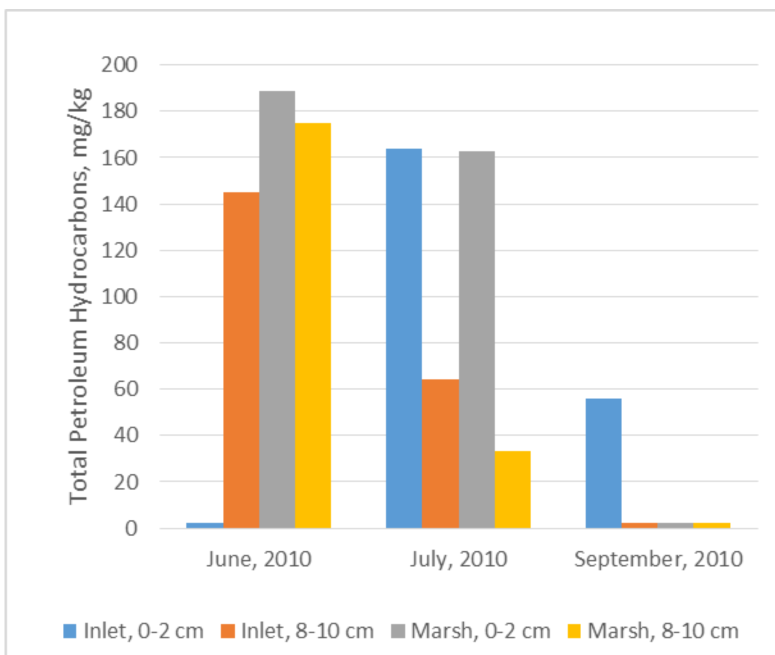
Based on studies on the impact of the Deepwater Horizon event, data indicate impacts from the Deepwater Horizon event have not extended to low relief, live bottom communities in the northern Gulf of Mexico (BOEM, 2015b). At this time the data are insufficient to make a reliable determination about long-term impacts.

Seagrasses

Microbial communities during and after the influx of petroleum hydrocarbons in a Gulf of Mexico coastal salt marsh on the eastern side of the Point Aux Pins peninsula, southwest of Bayou La Batre, Alabama were examined following the Deepwater Horizon oil spill (Beazley et al., 2012). Sediment cores were collected within the marsh stands ('Marsh' samples), in approximately 1 meter of water, 2 - 4 meters from shore outside the rush stand ('Shore' samples), and approximately 25 meters from the shore ('Inlet' samples).

Total hydrocarbon concentrations in salt marsh sediments were highest in June and July 2010 and decreased by September 2010 (Figure 5). Values were based on two or three replicates; the data show trends that generally indicated, with the exception of surficial inlet sediment, TPH levels were highest in June 2010 and fell to below detection by September 2010. For surficial inlet sediment, the limited data suggest a delayed process, with higher levels in July that decreased 66% by September (compared to the subsurface sediment decreasing by 56% between June and July, 2010).

Figure 5 Total Petroleum Hydrocarbons Levels in Marsh and Inlet Sediment Samples

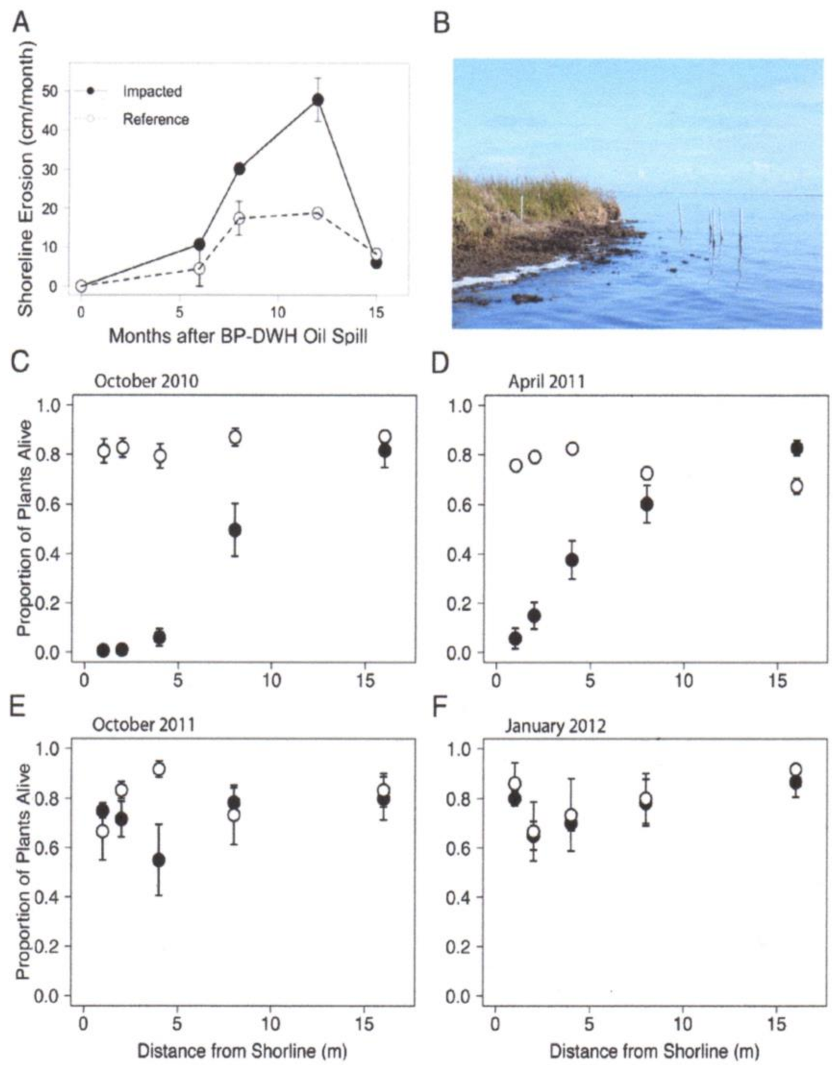


Source: Adapted from Beazley et al., 2012

The relative richness and abundance of the extant salt marsh hydrocarbon-degrading microbial community increased in hydrocarbon-contaminated sediments, then decreased once hydrocarbons fell below the detection limit. Functional genes involved in hydrocarbon degradation behaved similarly, enriched in hydrocarbon-contaminated sediments then declined once hydrocarbon concentrations decreased. A greater decrease in hydrocarbon levels in marsh grass sediments compared to inlet sediments (lacking marsh grass) suggested the marsh rhizosphere microbial communities could also contribute to hydrocarbon degradation.

Salt-marsh recovery (high resilience) and permanent marsh area loss after the Deepwater Horizon oil spill in Barataria Bay, Louisiana were reported on by Silliman et al. (2012). The authors found oil coverage primarily concentrated on the seaward edge of marshes and thresholds of oiling were associated with the severity of salt-marsh damage. Oil-related plant death on the edges of the marshes more than doubled shoreline erosion that likely will be permanent. After 18 months, in previously oiled but non-eroded areas, marsh grasses had largely recovered, and the elevated erosion rates had decreased to levels at reference marsh sites. Comparing the relative percentages of live vegetation at varying distance from shore from oil and reference sites (Figure 6), the clear trend is from nearly extinguished vegetation at the shoreline, to no impact 15 meters from shore in October 2010, to virtually identical percentages of live vegetation regardless of distance from shore by January of 2012.

FIGURE 6 SHORELINE EROSION AND PERCENTAGES OF VEGETATION ALIVE AT DISTANCE FROM SHORE, OILED AND REFERENCE SITES, 10/10-01/12



Source: Silliman et al., 2012

An extensive review of the status and impacts of the Deepwater Horizon event on coastal resources was compiled by Mendelssohn et al. (2012). Approximately 430 miles of marsh shorelines were oiled, with 176 miles either heavily or moderately oiled. Most of the oil from the oil spill that reached coastal marshes had been extensively weathered and marsh shoreline, generally not marsh interior, were primarily exposed to weathered oil. The primary marsh types affected were salt marshes; low- to intermediate- salinity marshes, and mangroves located on small islands and shorelines and as scattered stands within salt marshes.

Findings for the salt marshes in the Bay Jimmy area of northern Barataria Bay, Louisiana documented variable impacts depending on oiling intensity and species exposed. Thus, near complete mortality of the two dominant species were noted along heavily oiled shorelines. However, moderate oiling had no significant effect on *Spartina*, despite significantly affecting biomass and stem density of *Juncus*. As of fall 2011, many of the most heavily oiled shorelines had minimal to no recovery, and it is uncertain if natural re-vegetation can occur before shoreline erosion occurs. However, two years post-spill, some recovery had been noted, such as new shoots from oiled nodes on the stems and *Spartina* regenerated from rhizomes along moderately and some heavily oiled shorelines throughout Louisiana.

Although data on the impact of the Deepwater Horizon event on seagrasses are limited, based on the information discussed above, it appears the Deepwater Horizon event produced impacts commensurate with the amount of oiling that occurred in seagrass communities. Heavily oiled marshes were nearly completely devoid of live vegetation; whether these areas would re-vegetate before they erode is uncertain. Moderate to light oiling, however, resulted in relatively minor impacts and evidence of recovery to complete recovery appears within a few years. Longer-term impacts will take years of data collection and analysis before reliable assessments of impact are possible.

Based on these recent studies on the impact of the Deepwater Horizon event on seagrass communities, the limited data indicate the Deepwater Horizon event had significant adverse effects on certain seagrass communities. However, it is yet unclear whether heavily oiled areas will regenerate or be lost to erosion, in the relative short-term, and areas subject to moderate and light oiling appear capable of recovery.

Wetlands

Ten *Spartina* marshes were sampled in Louisiana in 2010 and 2011 after they were oiled by the Deepwater Horizon oil spill (McCall and Pennings, 2012). Abiotic conditions and plant variables were similar between oiled and non-oiled sites. *Spartina* leaf nitrogen content was higher in oiled sites and slightly higher in 2010 than 2011; *Littoraria* was unaffected by oil or sampling year. The density of crab burrows was higher in control sites and higher in 2011 than 2010. The terrestrial arthropod community was suppressed by 50% at oiled sites in 2010, but largely recovered in 2011. The authors reported similar patterns for five feeding guilds - predators, sucking herbivores, stem-boring herbivores, parasitoids, and detritivores tended to be suppressed at oiled sites by 25% to 50% in 2010 and had recovered in 2011. The authors offered that wetland vegetation may be less sensitive to oiling than fauna, which may be suppressed where plants show no visual signs of impact.

The utilization of salt-marsh habitats by transient and resident nekton was compared before and after the Deepwater Horizon event by Moody et al. (2013). They did not find significant differences in the recruitment of marsh-associated nekton in coastal Alabama following the spill, and they found little evidence for severe acute or persistent oil-induced impacts. The authors also found recruitment of many species of invertebrates in an Alabama marsh was not negatively affected by the event.

Advanced Visible Infrared Imaging Spectrometer (AVIRIS) data from Barataria Bay in September 2010 and August 2011 was used to map oil contamination and to examine the impacts to vegetation (Khanna et al., 2013). Vegetation stress was highest at the shoreline, decreasing with distance from the water line to some 14 meters inland in 2010. The study found varying degrees of re-vegetation in 2011, with the poorest recovery adjacent to shorelines which had displayed the greatest oil stress.

A review of 32 oil spills and field experiments found many cases where recovery of marshes occurred within one to two growing seasons, even without treatment (Michel and Rutherford, 2014). Recovery was shortest for spills in a warm climate, light to heavy oiling of the vegetation only (not the marsh surface), medium crude oils, and less intensive treatment.

BOEM (2015b) has noted a large body of information regarding impacts of the Deepwater Horizon event upon coastal wetlands is being developed through the NRDA process. BOEM concluded from the available evidence that following initial impacts from an oil spill, wetland recruitment and recovery appear to begin within a year.

Data on the impact of the Deepwater Horizon event on wetlands are limited but indicate the Deepwater Horizon event has had adverse effects on oiled wetlands and that recovery appears to be occurring within a few years. However, at this time data are insufficient to make a reliable determination about long-term impacts.

Deepwater Horizon Impacts on Socioeconomic Resources

Commercial Fishing

Potential negative economic effects of the Deepwater Horizon event on commercial and recreational fishing, as well as mariculture in the U.S. Gulf area, was estimated by computing potential losses throughout the fish value chain (Sumaila et al., 2012). The authors stated estimates of loss in commercial, recreational, and mariculture fisheries are dependent on the combination of initial mortality of fish species due to the oil spill as well as the continued economic unmarketability that can result when consumers believe marine products from the Gulf are less desirable because of real or perceived pollutants.

The authors estimated the potential losses in total revenues, total profits, wages, number of jobs, and economic impact throughout the wider economy. Conservative estimates of the economic effects of the oil spill consider market recovery time rather than longer ecological recovery time horizons. The authors stated the total revenue is the product of ex-vessel price and catch in the case of commercial fisheries; the total expenditure in the case of recreational fisheries; and the product of ex-farm price and production quantity in the case of mariculture. The added value or impact through the fish value chain includes indirect economic effects of fisheries and mariculture (e.g., boat building or maintenance, equipment supply, and the restaurant demand).

The authors estimated the value of total revenues that would be lost in the commercial fishing sector due to the Deepwater Horizon event (over the seven years following publication of the study) to be in the range of $0.5 - $2.7 billion. The equivalent losses in total profits, wages, and total economic impact are estimated at $0.3 - $1.4 billion, $0.1 - $0.8 billion, and $1.5 - $8.4 billion, respectively.

The largest losses would be incurred among fishermen targeting crustaceans such as shrimp, who would experience nearly 85% of the total estimated economic impact (Sumaila et al., 2012). In addition, between 5,000 and 9,000 jobs may be lost by commercial fisheries in the U.S. Gulf region. For the three mariculture states, Florida, Alabama, and Louisiana, the authors calculated the total loss in revenue as $94 - $157 million, with an economic impact of about $293 - $488 million. The authors estimate a loss of $44 - $73 million in total profit and $19 - $31 million in wages. The sector may lose well over 210 jobs, both full- and part-time. Overall, the majority of economic losses will occur in oyster mariculture.

Yearly commercial industries landings for finfish and shellfish indicate impacts of the Deepwater Horizon event are complex (Table 3-12; NMFS, 2015g; 2015i). On a Gulf-wide basis, data indicate there was a 20 - 25% decrease in total, shellfish, and shrimp landings between 2009 and 2010. From 2001 to 2013, total landings varied from 87% - 110% of 2009 landings while shrimp landings remained depressed, ranging from 82% - 88% of the 2009 catch. However, the Gulf-wide ex-vessel values of the total, shellfish, and shrimp catch tell a different story. From 2010 to 2013 the total landings were valued at 99% - 147% of the 2009 value; the value of shrimp landings ranged from 103% - 156% of the 2009 value. Thus, while landings were depressed following the Deepwater Horizon event, the value of the Gulf fisheries were unaffected or increased.

However, the narrative of Gulf-wide impacts does not reveal that state-wide impacts were highly variable. Gulf-wide statistics notwithstanding, Alabama and Mississippi bore the brunt of Deepwater Horizon commercial fishery impacts. For example, the west coast of Florida and Texas had slight decreases in 2010 landings but had increased ex-vessel values of their total and shrimp fisheries that ranged from 118% - 132% of 2009 values. However, impacts in Alabama and Mississippi were markedly different, showing 2010 total and shrimp landings were decreased by 50% - 60% and ex-vessel values decreased to 58% - 68% of their 2009 values, amounting to losses of some $13 - $16 million dollars in ex-vessel fisheries values in Alabama and Mississippi in 2010. There were no estimates of CPUE associated with any of these landings data to better evaluate potential impacts of the Deepwater Horizon event.

BOEM (2015b) concluded that detailed information on species found in the Gulf of Mexico continues to be developed and serves to support a baseline for determining potential impacts. Morphological defects, reduced cardiac efficiency, and decreased swimming performance may result in reduced feeding success and increased susceptibility to predation, and BOEM assumed that early life stage acute exposure to oil results in decreased survival to maturity. Without knowing the extent to which spawning overlapped spatially and temporally with waters contaminated by the 2010 Deepwater Horizon event, it is difficult to estimate the potential impacts to pelagic species.

In the absence of additional information, BOEM (2015b) conservatively assumed near 100% mortality among exposed embryonic fishes. This assumption aligns with the NMFS status review team report in assuming a maximal reduction of 20% to the bluefin tuna 2010 cohort as a result of the Deepwater Horizon event and estimating a less than 4% reduction in future spawning biomass (Atlantic Bluefin Tuna Status Review Team, 2011).

BOEM (2015b) re-examined the analysis for commercial fisheries presented in its earlier NEPA reviews (BOEM, 2012a; 2013a; 2014a) and reviewed newly available information. BOEM acknowledged that incomplete or unavailable information remain, including information on potential impacts to embryonic pelagic fishes. BOEM noted recent studies suggesting fishes recruited near the time of the Deepwater Horizon event may not have suffered catastrophic losses (Fodrie and Heck, 2011; Atlantic Bluefin Tuna Status Review Team, 2011; NMFS, 2013; Rooker et al., 2013). BOEM (2015b) noted existing information supports commercial fishing as acutely affected, and having experienced significant adverse impacts from the event but acknowledged long term effects remain unknown.

Based on the above information on impacts to fishes and the available annual data on commercial (and recreational) landings, the short-term impact of the Deepwater Horizon event on commercial fishing appears to largely be restricted to the closures of fishing areas during the active oil spill and for several months thereafter. Landings data do not indicate the event had a catastrophic impact on commercial fishing. However, at this time data are insufficient to make a reliable determination about long-term impacts.

Recreational Fishing

Data on recreational fisheries were presented in Table 3-15. There was a 5% - 7% decrease in recreational anglers and trips in 2010, perhaps due to NOAA closures, but the values have increased each year and in 2012 there were more anglers taking more trips than in 2009. Unlike commercial fisheries impacts, Alabama and Mississippi did not show any greater impact from the Deepwater Horizon event. To the contrary, these states showed level or increased angler participation, while Florida showed a 7% - 9% decrease in angler participation and trips.

Impacts to the recreational fishing industry may be determined by the ability of people and businesses supporting the industry to withstand the impacts of the spill in certain areas BOEM (2013a). Approximate two-thirds of the Gulf remained open to fishing in the months after the spill, but a number of fishermen in affected areas were idled directly after the spill. Louisiana officials opened a number of areas to recreational fishing in mid-July 2010 (Federal Reserve Bank of Atlanta, 2010). Also, a number of people were supported over the short term by BP claims and by the Vessels of Opportunity Program, receiving approximately $740 million in compensation payments and more than 30,000 claims as of February 10, 2012 (Gulf Coast Claims Facility, 2012). The success of government policy initiatives also will affect this outcome, such as Louisiana’s receipt of $78 million from BP to monitor seafood and to promote tourism. BOEM (2015b) re-examined the analysis for recreational fisheries presented in its earlier NEPA reviews (BOEM, 2012a; 2013a; 2014a) and newly available information and found no new significant information that changed its prior assessments on recreational fishing impacts.

Relevant information related to recreational fishing can also be found in Sections 3.3.3 and 3.4.2 of this EA. Based on this information on fishes and fisheries and available annual data on recreational seafood landings, the short-term impact of the Deepwater Horizon event on recreational fishing appears to largely be restricted to the closures of fishing areas during the active oil spill and for several months thereafter. Data on the impact of the Deepwater Horizon event on recreational fishing are more complete than for many other potentially affected resources and suggest that short-term impacts on recreational fishing were limited. Longer-term impacts may yet become apparent, e.g., differential age-class impacts, and at this time, data are insufficient to make a reliable determination about long-term impacts.

Human Health

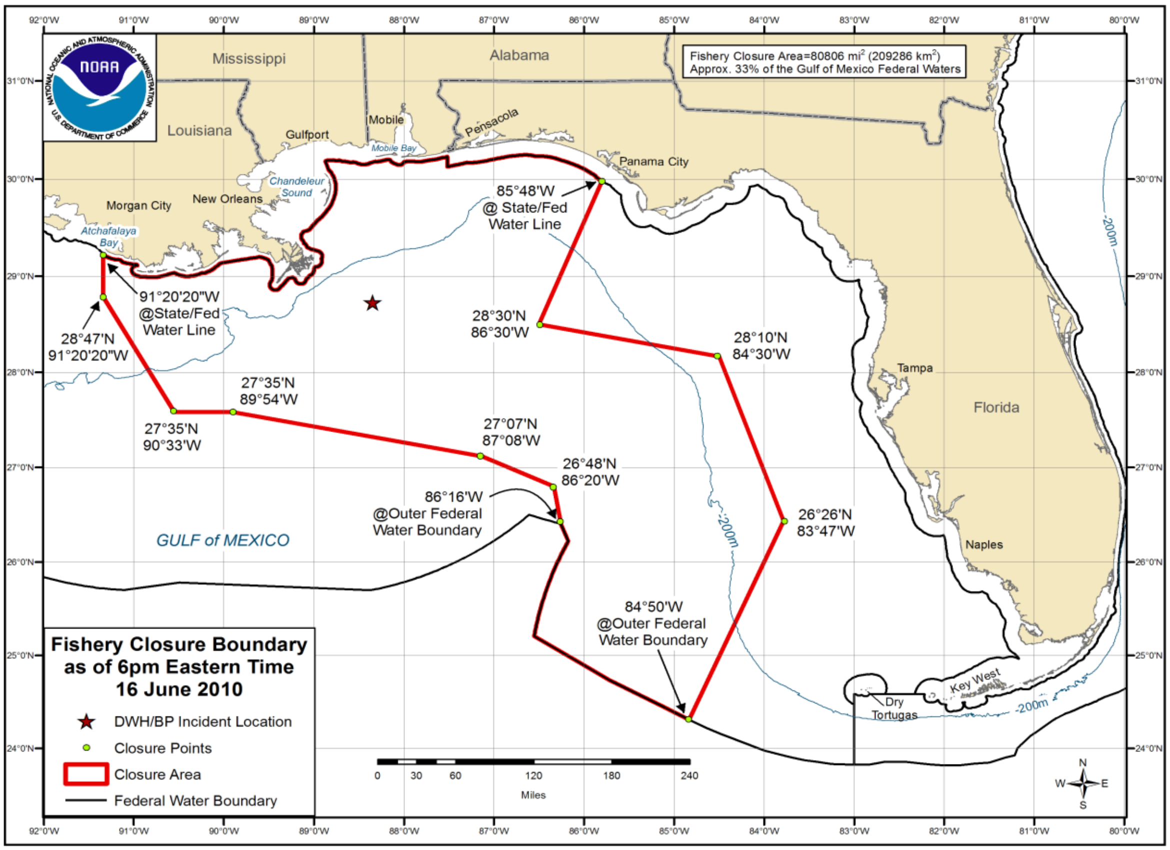
After the Deepwater Horizon event, NOAA Fisheries Service instituted fishery closures to ensure public safety. Closures changed in response to the plume, and on June 16, 2010, the fishery closure area reached the greatest coverage at 80,806 square miles (Figure 7).

A multi-agency Operational Science Advisory Team (OSAT), under the direction of the USCG, was convened to provide information to help guide response activities and to provide a better understanding of the potential environmental and health risks after the spill. A summary of the OSAT findings include the following (OSAT, 2014):

- In December 2010, OSAT-1 concluded that “there is no actionable oil or sediments in the deepwater or offshore zones.” In addition, none of the roughly 17,000 water samples collected and analyzed exceeded the EPA’s benchmarks for protection of human health.
- In July 2011, OSAT-1 Addendum stated that of 3,500 toxicity tests conducted, 90% showed no statistically significant effects.
- In February 2011, OSAT-2 found that residual oil in nearshore and sandy shoreline areas was highly weathered, and concentrations of constituents of concern were well below levels of concern for human health.

- In January and May 2014, OSAT-3 reported on attempts to locate and recover potential buried material. Field investigations found little or no visible oil in excavations across seven Louisiana barrier islands; less than 2% of augered holes had oil levels that required cleanup; and efforts to locate and recover potential material were ended.

FIGURE 7 FISHERY CLOSURE BOUNDARY IN RESPONSE TO DEEPWATER HORIZON EVENT



Source: NOAA Fisheries Southeast Regional Office, 2016

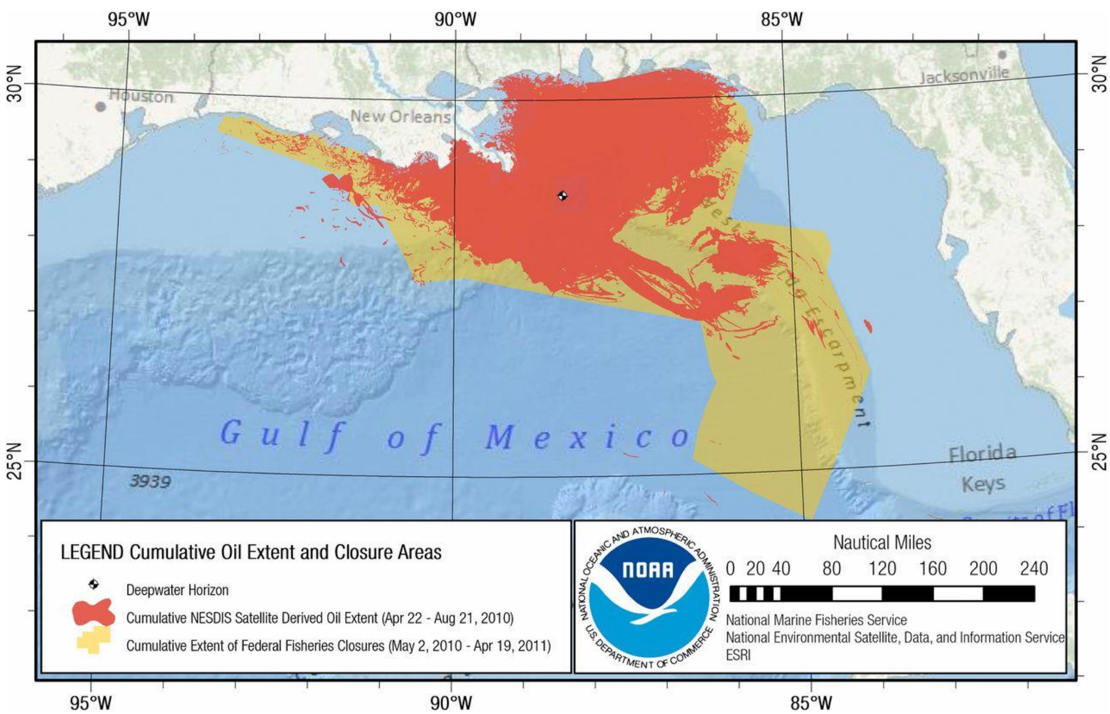
A collaboration of federal agencies that included FDA, NOAA, EPA, and Centers for Disease Control, as well as their counterpart state agencies, established a unified seafood protocol federal seafood safety response to the Deepwater Horizon event (Ylitalo et al., 2012). As part of the protocol, these agencies developed a seafood safety risk assessment approach for use in determining whether federal or state waters would be reopened to commercial and recreational fisheries. In developing the human health risk assessment, a suite of 13 PAH analytes were selected as indicators of human health risk. Of the 13 PAHs, cancer risk factors that were available for 7 PAHs; the 6 PAHs with non-cancer endpoints used their EPA reference dose (RfD) as the basis for their safety criteria.

The risk assessment was further developed based on a 5-year exposure, a lifetime cancer risk of 10^{-5}; the 90th percentile for U.S. seafood consumption (meal size) and the 90th percentile for U.S. seafood consumption frequency (16.4 seafood meals per month); an adult body weight of 80 kg; and an average lifetime of 78 years. The selection of a 5-year exposure period was based on the light crude oil spilled, warm sea temperatures, spill location 80 km offshore, and the metabolic capacities of the seafood species likely affected.

Sampling was based on the location and trajectory of the spill. Figure 8 depicts the extent of the spill from April 22 to August 21, 2010. Figure 9 shows the locations of the sites sampled from April 28, 2010 to March 31, 2011.

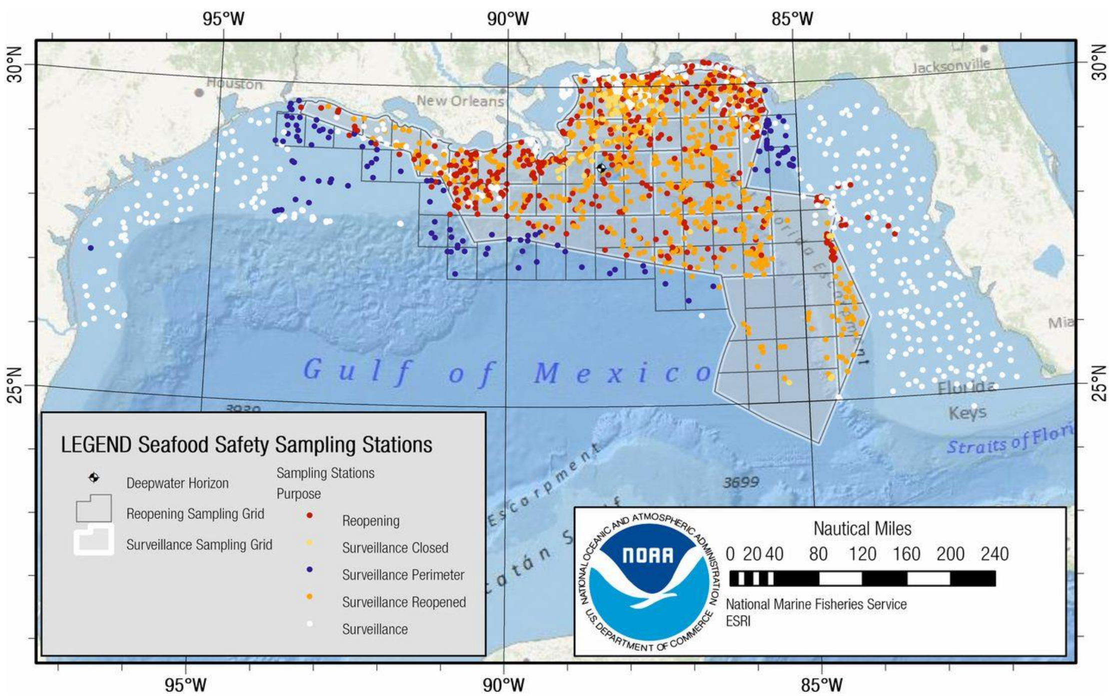
Concerns were raised about the selected or default values used to develop LOCs as not reflecting current risk assessment practices and protecting vulnerable populations (Rotkin-Ellman et al., 2012). The concerns stated that far more seafood samples exceed LOCs if the exposure is re-calculated for more sensitive subpopulations.

FIGURE 8 EXTENT OF THE DEEPWATER HORIZON OILING, APRIL 22, 2010 – AUGUST 21, 2010



Source: Ylitalo et al., 2012

FIGURE 9 SEAFOOD SAMPLING SITES, APRIL 28, 2010 - MARCH 31, 2011



Source: Ylitalo et al., 2012

To date, consumption of contaminated Gulf of Mexico seafood has not resulted in a documented adverse health outcome. At this time, available information supports the conclusion that the actions undertaken by the federal and state agencies responsible for ensuring continuing access of consumers to safe seafood products appear to have succeeded.

The possibility that longer-term impacts may yet become apparent cannot be discounted.

Environmental Justice

The Deepwater Horizon event is the largest spill in U.S. waters. In its three months of uncontrolled discharge of crude oil and the months thereafter, dramatic changes occurred in Gulf coast communities. Up to a third of the Gulf of Mexico was closed following the spill. Commercial and recreational fishing grounds were closed. Vessels of opportunity were contracted by BP. Offshore oil and gas operations were interrupted. Oil spill response, recovery, and clean-up activities swelled. Tourism and support services withered. BP established a claims center funded at $20 billion.

Communities were clearly affected, and the socioeconomic impacts of the Deepwater Horizon event will take years to sort out and quantify. The objective of the ongoing NRDA effort is to assess the costs incurred - environmental, social, and economic - by whom, i.e., which residents and industries were affected and to what degree, as a result of the incident.

Osofsky et al. (2012) discussed three broad environmental justice concerns related to the Deepwater Horizon event. One area of environmental justice concern was the spill response, including the distribution of waste disposal facilities among minority/low income communities as well as the actual distribution of disposed wastes among disposal facilities. The second concern related to compensation, and included federal, state, and local responses as well as public and private litigation. The third concern related to employment impacts (i.e., employment losses and opportunities in industrial sectors that benefitted and adversely affected by the event) and worker impacts (i.e., the vulnerability and health and safety concerns for cleanup workers and the safety and compensation of oil rig workers). Of the concerns listed by Osofsky et al. (2012), only waste disposal is relevant to the activities covered by the proposed General Permit.

A study that examined the impacts of wastes resulting from the Deepwater Horizon cleanup found that wastes disposed at the approved landfills disproportionately affected minority communities along the Gulf (Bullard, 2010). Specifically, the percent minority residents living within one mile of the disposal facilities were higher than state averages (see Table 1). As discussed in Chapter 3.6.1.5, despite the amount of Deepwater Horizon event-related wastes that were sent to onshore waste handling facilities, the impact of this onshore disposal of was negligible (< 2%), in view of the capacity of available, nearby waste disposal facilities.

TABLE 1 MINORITY POPULATIONS NEAR DISPOSAL SITES

Landfill Location/Name		Tons Disposed	Minority Population Within One Mile Radius
Louisiana	Tide Water Landfill	2,204	93.6%
Florida	Springhill Regional Landfill	14,288	76.0%
Alabama	Chastang Landfill	6,008	56.2%
Louisiana	River Birch Landfill	1,406	53.2%
Louisiana	Jefferson Parish Sanitary Landfill	225	51.7%
Louisiana	Colonial Landfill	7,729	34.7%
Louisiana	Jefferson Davis Parish Landfill	182	19.2%
Alabama	Magnolia Landfill	5,966	11.5%

Source: Bullard, 2010

The commercial and recreational fishing industries are an example of the complexity of such interactions. Despite extensive closures of fishing grounds in both state and federal waters, the landings and ex-vessel values of these fisheries, on a Gulf-wide basis, appear to be minor. However, bearing the burden of Deepwater Horizon impacts was not shared equitably among the states (see the discussion on commercial fisheries in Chapters 3.4.1 and 3.6.3.1 and recreational fisheries in Chapters 3.4.2 and 3.6.3.2 for detailed discussions). While Florida and Texas appear to have been unaffected, Alabama and Mississippi saw substantial decreases in seafood landings and ex-vessel values, with Louisiana falling between these two levels of impact. Such impacts, are not likely to have resulted in equitable effects among potentially affected commercial fishermen or operations because of a wide range of personal and business circumstances. Some potentially affected commercial fishermen or operations would have had better access to sufficient resources and be able to sustain themselves until the fisheries were again fully functional. Others, who may not have access to such resources, would have been more seriously affected by the fisheries closures that occurred as a result of the Deepwater Horizon event. Government and private responses have mitigated some of the potential adverse impacts.

Currently available data are not adequate to assess the impacts of the Deepwater Horizon event and environmental justice concerns. There are little or no data to assess whether the costs were equally shared across the demographic spectrum of Gulf coast communities.

References